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Meat quality parameters of descendants by grading hybridization of Boer goat and Guanzhong Dairy goat

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ABSTRACT

Chemical composition, cholesterol levels, fatty acid profile, meat taste, and quality parameters were evaluated in 48 buck kids from goats of the Guanzhong Dairy breed (Group G) and their crosses (Group F1: 1/2 Boer♂ × 1/2 Guanzhong Dairy♀; Group F2: 3/4 Boer♂ × 1/4 Guanzhong Dairy♀; Group F3: 7/8 Boer♂ × 1/8 Guanzhong Dairy♀) at different ages of slaughter (6, 8 and 10 months). Results indicated that grading hybridization ($P < 0.05$) affected meat nutritive value. The muscle of hybrid goats had lower crude fat and cholesterol, higher crude protein, and greater proportion of C18:2 and C18:3 than that of Group G at each age. Group F1 goats had better ($P < 0.05$) desirable fatty acid (DFA) and polyunsaturated fatty acid (PUFA) to saturated fatty acid (SFA) ratios and greater (C18:0 + C18:1/C16:0) ratios ($P < 0.01$) than those of the other genotypes. Furthermore, the muscles of hybrid goats were tenderer and juicier compared to Group G. In all four groups, cholesterol levels increased ($P < 0.01$), muscle color became redder ($P < 0.05$) and tenderness decreased ($P < 0.05$) with increasing age. The low level of lipids and cholesterol, good meat quality, and the higher ratio of unsaturated to SFA in Group F1 indicate better quality for human consumption.

1. Introduction

Goat meat (Chevon) is an important protein source throughout the world especially in developing countries (Biswas, Das, Banerjee, & Sharma, 2007). In North and Northwest China, goat production has been an economically important activity, helping to alleviate poverty and improve nutrition. However, as a result of the traditionally low economic significance attributed to these animals in many countries, compared to sheep and cattle, knowledge of meat yield and quality of indigenous goats is limited.

The Guanzhong Dairy goat is popular for milk production in China. It has been cross-bred from local Fuping and "Xinong" Saanen goats for many years. It is a hardy breed, which is able to withstand coarse feed and steep slopes. There are now about 180,000 dairy goats feeding in Fuping County (He, Sheng, Wang, & Zhang, 2006. However, the lack of technology utilized in goat breeding and meat production is a constraint to commercial goat production. The use of sires of imported goat breeds in crossbreeding programs could improve carcass parameters and meat quality traits. For this reason, government programs have encouraged the introduction of exotic breeds with an emphasis on meat production. In 1994, the Boer breed was imported into China and bred with the indigenous goats, including Hailun, Hongtong, Laoshan Dairy, Nanjiang Yellow, Guanzhong Dairy, and others (Shrestha & Fahmy, 2007) to improve meat quality and meet the growing demand for goat meat.

Goat meat composition and quality are known to be influenced by genotype (Oman, Waldron, Griffin, & Savell, 2000; Tshabalala, Strydom, Webb, & de Kock, 2003), age (Todaro et al., 2002), sex (Hogg, Mercer, Mortimer, Kirton, & Duganzich, 1992; Todaro et al., 2004), diet, and production methods (Johnson & McGowan, 1998; Marinova, Banskalieva, Alexandrov, Tzvetkova, & Stanchev, 2001). Therefore, the nutritional value and quality of goat meat needs to be assessed in terms of breed, slaughter age, and castration. However, published data on chemical composition, nutritional, and sensory attributes of cross-bred goat meat is scarce. In China, most research on goat meat has been related to production and factors which affect their nutritive value (Gong, Li, Liu, Dong, & Zhang, 2002; Liu, Li, Gang, & Liu, 2003). Little information has been reported on the effect of cross breeding and age at slaughter on fat components and sensory attributes.

The main objectives of this study were to evaluate the effects of species and grading hybridization, as well as age at slaughter, on meat quality, chemical composition, and sensory characteristics

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of meat obtained from goats of the Guanzhong Dairy and Boer breeds raised on natural pasture in northwest China.

2.2. Materials and methods

2.1. Animal management and experimental design

Four goat genotypes, Guanzhong Dairy breed (Group G), and their crosses (Group F1:1/2 Boer♂ × 1/2 Guanzhong Dairy ♀; Group F2: 3/4 Boer♂ × 1/4 Guanzhong Dairy♀; Group F3:7/8 Boer♂ × 1/8 Guanzhong Dairy♀) were used. The animals selected were 48 buck kids, 12 bucks from each of the four genotypes. The study was approved by the College of Animal Science of Northwest A & F University. The animals were selected from Baoji Boer Goat Company and Linyou Boer Goat Company, Linyou, ShaanXi, China. The goats were raised in Linyou which is located at 34°27'E latitude and 108°07'N longitude, at altitudes over 480 m. This location has a temperate continental monsoon climate. The animals were weaned at approximately 90 days of age. They were reared and castrated by the same methods used to produce Chevon carcasses. After weaning the kids were raised on local pasture with *ad libitum* access to grassy Lucerne hay goat pellets (CP 18% and ME 12.3 MJ/DM energy per kg pellets). The goats were slaughtered using standard commercial procedures (Dhanda, Taylor, McCosker, & Murray, 1999a). A total of four animals in each genotype were slaughtered at each of three ages (6, 8, and 10 months).

2.2. Slaughter and samples collection

All animals were weighed upon arrival at the abattoir. They were kept in covered yards and deprived of feed overnight (18 h), but permitted free access to water. The goats were slaughtered by cutting their throats and allowing the blood to drain. After bleeding, the animals were hung to remove the skin, head, fore feet, hind feet and viscera. Dressed carcasses were then weighed before being chilled at 2 °C for 24 h. The cold carcasses were weighed, split down the dorsal midline and the left side used for meat quality and nutritive value measurements. The *longissimus thoracis* (LT) muscles were collected for measurements and analyses.

2.3. Analysis of meat quality

The ultimate pH (pH_{24}, measured at 24 h after slaughter) was determined using a TPS-MC80 pH meter (TPS Pty Ltd., Brisbane, Australia), by insertion of the electrode into the LT muscle at the 12/13th rib site on the chilled carcasses. Muscle color was measured at the same site, using a Minolta CR-310 Chroma-meter (where L^*, a^* and b^* represent relative lightness, redness and yellowness, respectively). The LT muscle was used for determining intramuscular fat, water-holding capacity (WHC), cooking loss and shear force values. The WHC was estimated by the filter paper press technique (Trout, 1988). The muscles were weighed, placed in a plastic bag and cooked in a water bath at 85 °C for 45 min, until an internal temperature of 70 °C was attained. Samples were then cooled and reweighed. The percent loss in weight was recorded as cooking loss% (Babikerm, Elkhiderml, & Shafie, 1990). After measurement of cooking loss, meat tenderness was assessed by measuring the shear force of cooked meat samples. After equilibration at room temperature, at least three cores were prepared from each meat sample measuring 1 cm^2 in cross-section and at least 3 cm long, cut with the muscle fibres parallel to the longitudinal axis of the sample.

A texture analyzer model TA-XT2 (Stable Micro Systems, Godalming, UK) equipped with a Warner–Bratzler blade was used to transversely shear cores at a cross-head speed of 1 mm/s. The shear force was recorded as the maximum peak force (kg) required to cut each core of meat. Higher shear force values indicated tougher meat.

2.4. Chemical composition of meat

2.4.1. Chemical composition of muscle

The chemical characteristics of muscle (moisture, muscle crude fat, crude protein and ash) were analyzed using standard analytical methods (AOAC, 1990) on the LT muscle. Muscle crude fat was also determined on the LT muscle. A minimal of three replicates was made per sample for each type of analysis.

2.4.2. Fatty acid analysis by GC

Three grams of minced LT muscle was extracted using the procedure of Folch, Less, and Stanley (1957). The tissue was homogenized with chloroform/methanol (2:1) to produce a final volume 20-times the volume of the tissue sample. Methyl esters of the fatty acid components of neutral triacylglycerols were prepared according to the NaOH–methanol method (Slover & Lanza, 1979). Fatty acid methyl esters (FAME) were analyzed using a HITACHI 663-30 (Hitachi, Tokyo, Japan) Gas Chromatograph equipped with flame ionization detector and Varian (Walnut Creek, CA, USA) fused silica capillary column (100 m × 0.25 mm and 0.20 μm of biscyanopropyl polysiloxane, CP-Sil 88). Following sample injection, the column temperature was kept for 4 min at 155 °C, then increased at 2 °C/min to 250 °C and maintained at that level until all esters had been eluted. The injector and detector temperatures were 250 °C and 260 °C, respectively. The carrier gas was nitrogen at 30 ml min^{-1}.

The determination of the fatty acids was carried out by comparing sample FAME peak relative retention times with those obtained for Sigma (USA) standards. The peak areas were determined by HW computing integrator program (Qian Pu instruments, China); data were calculated as normalized area percentages.

2.4.3. Total cholesterol concentration quantification

Total cholesterol concentrations in BF muscles were determined colorimetrically by the procedure of Bohac, Rhee, and Ono (1988). The absorbance of the cooled and colored mixture of cholesterol and glacial acetic acid–$FeSO_4$–H_2SO_4 was read at 490 nm against the reagent blank.

2.5. Sensory evaluation

Sensory evaluation was carried out in a controlled sensory analysis laboratory at the University of Northwest A & F. Samples of cooked LT muscle were evaluated for eating quality. The cooking method was similar to that used for cooking loss determination. Eight semi-trained panelists assessed the meat for flavor, tenderness, juiciness, residue and overall acceptability. Three representative meat samples were collected from each genotype and age-at-slaughter group. Each cooked meat sample was cut into eight 1 cm^2 pieces, coded with unique randomly selected three digit numbers and served in random sequences. Sensory evaluation was carried out in three sessions per day on four consecutive days. During each session, panelists received six different samples for appraisal using a 9-point hedonic scale (9, like extremely; 1, dislike extremely).

2.6. Statistical analysis

Data was analyzed using the General Linear Model (GLM) procedure of the Statistical Analysis Software package (SAS, 1999). Meat chemical composition, quality parameters and fatty acid